

## CLAIMS

What is claimed is:

1. A syngas catalyst comprising  
a refractory support; and  
a metal catalyst material comprising an alloy of rhodium and at least one other second metal, wherein the alloy is substantially free of nickel.
2. The partial oxidation catalyst according to claim 1 wherein the rhodium alloy comprises a second metal selected from the group consisting of Group VIII metals, rhenium, tungsten, zirconium and mixtures thereof.
3. The partial oxidation catalyst according to claim 2 wherein the catalyst comprises between 1 and 10 percent of the metal by weight of the catalyst.
4. The partial oxidation catalyst according to claim 1 wherein the catalyst comprises between 1 and 10 percent of rhodium by weight of the catalyst.
5. The partial oxidation catalyst according to claim 1 wherein the rhodium alloy comprises ruthenium.
6. The partial oxidation catalyst according to claim 1 wherein the rhodium alloy comprises iridium.
7. The partial oxidation catalyst according to claim 1 wherein the rhodium alloy increases the melting point of the metal catalyst material to a temperature above 1964°C.
8. The partial oxidation catalyst according to claim 1 wherein the catalyst has a metal surface area equal to or greater than 0.8 square meter per gram of catalyst.
9. The partial oxidation catalyst according to claim 1 wherein said refractory support comprises a material selected from the group consisting of modified, partially-stabilized or unmodified alumina, modified, partially-stabilized or unmodified zirconia, titania, and combinations thereof.

10. The partial oxidation catalyst according to claim 9 wherein said refractory support comprises a material selected from the group consisting of modified alumina, zirconia, and combinations thereof.

11. The partial oxidation catalyst according to claim 10 wherein said modified alumina is modified with a modifying agent selected from the group consisting of aluminum, rare earth metals, alkali earth metals, transition metals, and combinations thereof.

12. The partial oxidation catalyst according to claim 10 wherein said modified alumina is modified with a modifying agent selected from the group consisting of lanthanum, magnesium, aluminum, and combinations thereof.

13. The partial oxidation catalyst according to claim 1 wherein the metal catalyst material further comprises at least one promoter.

14. The partial oxidation catalyst according to claim 13 wherein said promoter comprises an elements selected from the group consisting of lanthanides metal, alkali earth metals, and combinations thereof.

15. The partial oxidation catalyst according to claim 13 wherein said promoter comprises one element selected from the group consisting of La, Ce, Pr, Nd, Pm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu their corresponding oxides, their corresponding ions, and mixtures thereof.

16. The partial oxidation catalyst according to claim 13 wherein said promoter comprises samarium.

17. A process for producing synthesis gas comprising:

converting at least a portion of a feedstream comprising a hydrocarbon-containing gas and an atomic oxygen-containing gas over a syngas catalyst, under conditions effective to produce a gas stream comprising hydrogen and carbon monoxide,

wherein the syngas catalyst comprises a metal catalyst material comprising an alloy of rhodium and at least one other second metal, and the alloy is substantially free of nickel.

18. The process according to claim 17 wherein the rhodium alloy comprises a second metal selected from the group consisting of Group VIII metals, rhenium, tungsten, zirconium and mixtures thereof.

19. The process according to claim 17 wherein the rhodium alloy comprises ruthenium.

20. The process according to claim 17 wherein the rhodium alloy comprises iridium.
21. The process according to claim 17 wherein the rhodium alloy increases the melting point of the metal catalyst material to a temperature above 1964°C.
22. The process according to claim 17 wherein the hydrocarbon-containing gas comprises methane or natural gas.
23. The process according to claim 17 wherein the atomic oxygen-containing gas comprises diatomic oxygen, water, carbon dioxide, and combinations thereof.
24. The process according to claim 17 wherein the atomic oxygen-containing gas comprises diatomic oxygen.
25. The process according to claim 17 wherein the conversion step comprises partial oxidation, steam reforming, dry reforming, oxidative dehydrogenation, or combinations over said syngas catalyst.
26. The process according to claim 17 wherein the process exhibits a hydrocarbon conversion equal to or greater than 80 %, and a hydrogen selectivity equal to or greater than 80 %, after at least 48 hours under operating conditions of at least greater than or equal to 2 atmospheres.
27. The process according to claim 17 wherein the process exhibits a hydrocarbon conversion equal to or greater than 85 %, and a hydrogen selectivity equal to or greater than 85 %, after at least 48 hours under operating conditions of at least greater than or equal to 2 atmospheres.
28. A hydrocarbon gas to liquid conversion process comprising:
  - (a) converting at least a portion of a feedstream comprising a hydrocarbon containing gas and an atomic oxygen-containing gas over a syngas catalyst comprising an alloy of rhodium and at least one other second metal, wherein the alloy is substantially free of nickel, under conditions effective to produce a gas stream comprising hydrogen and carbon monoxide.
  - (b) reacting at least a portion of the gas stream from step (a) in a hydrocarbon synthesis reactor under conditions effective to produce C<sub>5+</sub> hydrocarbons.
29. The process according to claim 28 wherein the rhodium alloy comprises a second metal selected from the group consisting of Group VIII metals, rhenium, tungsten, zirconium and mixtures thereof.

30. The process according to claim 28 wherein the rhodium alloy comprises ruthenium.
31. The process according to claim 28 wherein the rhodium alloy comprises iridium.
32. The process according to claim 28 wherein step (a) exhibits a hydrocarbon conversion equal to or greater than 80 %, and a hydrogen selectivity equal to or greater than 80 %, after at least 48 hours under operating conditions of at least greater than or equal to 2 atmospheres.
33. The process according to claim 28 wherein step (a) exhibits a hydrocarbon conversion equal to or greater than 85 %, and a hydrogen selectivity equal to or greater than 85 %, after at least 48 hours under operating conditions of at least greater than or equal to 2 atmospheres.
34. The process according to claim 28 wherein the hydrocarbon containing gas in step (a) comprises methane or natural gas.
35. The process according to claim 28 wherein the atomic oxygen-containing gas in step (a) comprises diatomic oxygen, water, carbon dioxide, and combinations thereof.
36. The process according to claim 28 wherein step (a) comprises partial oxidation, steam reforming, dry reforming, oxidative dehydrogenation, or combinations over said syngas catalyst.
37. The process according to claim 28 wherein step (a) comprises catalytic partial oxidation.
38. The process according to claim 28 wherein step (a) comprises a Fischer-Tropsch synthesis.